Chapter 3

New Instrument Approach Procedures

Although substantial increases in capacity are best achieved through the building of new airports and new runways at existing airports, large projects like these are only completed after a long-term process of planning and construction. In an effort to meet the increasing demands on the aviation system in the near-term, the FAA has initiated improvements in air traffic control procedures designed to increase utilization of multiple runways and provide additional capacity at existing airports, while maintaining or improving the current level of safety in aircraft operations.

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In FY94, more than half of all delays were attributed to adverse weather conditions. These delays are in part the result of instrument approach procedures that are much more restrictive than the visual procedures in effect during better weather conditions. Much of this delay could be eliminated if the approach procedures used during instrument meteorological conditions (IMC) were closer to those observed during visual meteorological conditions (VMC).

During the past few years, the FAA has been developing new capacity-enhancing approach procedures. These are multiple approach procedures aimed at increasing the number of airports and runway combinations that can be used simultaneously, either independently or dependently, in less than visual approach conditions. "Independent" procedures are so called because aircraft arriving along one flight path do not affect arrivals along another flight path. "Dependent" procedures place restrictions between two arrival streams of aircraft because their proximity to each other has the potential for some interference. The testing of these new procedures has been thorough, involving various validation methods, including real-time simulations and live demonstrations at selected airports.

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As a result of these development efforts, new technologies have been implemented and new national standards have been published that enable the use of these capacity-enhancing approach procedures:

- Simultaneous (independent) parallel approaches using the Precision Runway Monitor (PRM) to runways separated by 3,400 to 4,300 feet — published November 1991. The first PRM was commissioned at Raleigh-Durham International Airport in June 1993.

- Improved dependent parallel approaches to runways separated by 2,500 to 4,299 feet that reduce the required diagonal separation from 2.0 to 1.5 nm — published June 1992.
- Reduced longitudinal separation on wet runways from 3 to 2.5 nm inside the final approach fix (FAF) — published June 1992.
- Dependent converging instrument approaches using the Converging Runway Display Aid (CRDA) — published November 1992. The ARTS IIIA CRDA software upgrade is available for installation.
- Use of Flight Management System (FMS) computers to transition aircraft from the en route phase of flight to existing charted visual flight procedures (CVFP) and instrument landing system (ILS) approaches — published December 1992.
- Simultaneous ILS and localizer directional aid (LDA) approaches — procedures implemented at San Francisco International Airport.

The following sections present a brief description of the most promising approach concepts currently under development, including their estimated benefits, supporting technology, and candidate airports that might benefit from the new procedures.

3.1 Independent Parallel Approaches Using the Precision Runway Monitor (PRM)

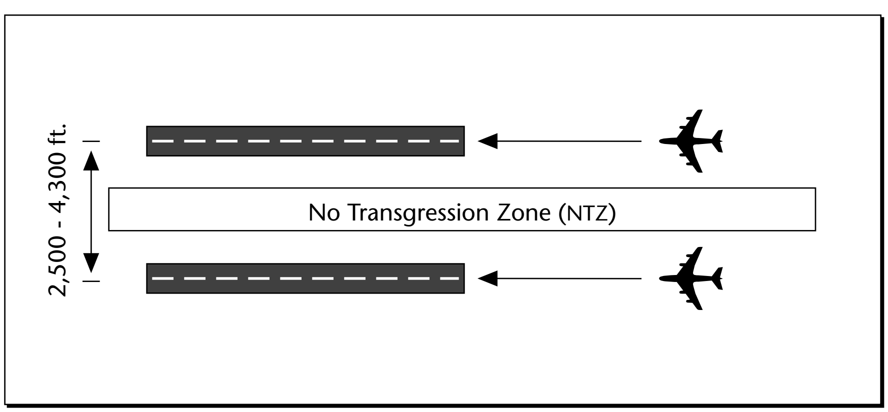
The FAA has authorized independent (simultaneous) instrument approaches to dual parallel runways since 1962, doubling the arrival capacity of an airport when visual approaches cannot be conducted. The spacing between the parallel runways was initially required to be at least 5,000 feet, but was reduced to 4,300 feet in 1974. More than 15 U.S. airports are currently authorized to operate such independent parallel instrument approaches. A new national standard published in November 1991 authorized simultaneous (independent) parallel approaches to runways separated by 3,400 to 4,300 feet when the Precision Runway Monitor is in use.

The PRM system consists of an improved monopulse antenna system that provides high azimuth and range accuracy and higher data rates than the current terminal Airport Surveillance Radar (ASR) systems. The E-Scan radar uses an electronic scanning antenna which is capable of updating an aircraft's position every half second. This update rate is an order of magnitude greater than the current ASR systems. The PRM processing system allows air traffic controllers to monitor the parallel approach courses on high-resolution color displays and generates controller alerts when an aircraft blunders off course.

Demonstrations of PRM technology were conducted at Raleigh-Durham International Airport in 1989 and 1990 using the E-Scan radar. The first PRM system (E-Scan) was commissioned at Raleigh Durham International Airport in June 1993. The second system was delivered to Minneapolis in 1995. Studies are being conducted to determine appropriate sites for the remaining systems.

Simulations were conducted at the FAA Technical Center in attempts to determine the minimum runway spacing between triple parallel runways spaced 4,000 and 5,300 feet apart in 1995 and in 1996 using enhanced procedures. Recommendations on this procedure is expected in 1996. Simulations were also conducted in 1995 on simultaneous ILS approaches to dual parallel runways spaced 3,000 feet apart with one localizer offset 2.5 degrees. This procedure was recommended in 1995 and a final report will be completed in 1996. While the results are pending, if successful, the average capacity gains expected from the use of these improved approaches would be, at a minimum, 12-17 arrivals per hour.

Figure 3-1. Independent Parallel Instrument Approaches Using the Precision Runway Monitor (PRM)



3.2 Independent Parallel Approaches Using the Final Monitor Aid (FMA) with Current Radar Systems

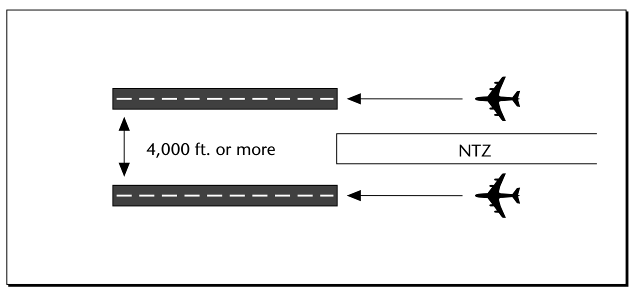
The Final Monitor Aid is a high resolution color display that is equipped with the controller alert hardware and software that is used in the PRM system. The display includes alert algorithms that provide aircraft track predictors; a color change alert when an aircraft penetrates or is predicted to penetrate the no transgression zone (NTZ); a color change alert if the aircraft transponder becomes inoperative; and digital mapping.

Studies revealed that using the fma with current radar systems (4.8 second update rate) would improve the ability of controllers to detect blunders, thereby allowing a reduction in the minimum centerline spacing for independent parallel approaches. Real-time simulations, utilizing a "miss-distance" of 500 feet to allow for the possible effects of wake vortex, were completed at the FAA Technical Center for dual and triple parallel runways spaced 4,300 feet apart. Procedures have been published in an FAA Order. Further simulations will be conducted for parallel runways spaced 4,000 feet apart. Figure 3-2 illustrates parallel instrument approaches using the FMA. Table 3-1 lists airports that have, or plan to have, parallel runways separated by 4,000 feet or more and indicates the average capacity gains expected from these improved approaches.

Table 3-1. Candidate Airports for Independent Parallel Approaches Using the Final Monitor Aid (FMA)

Candidates Among Top 100 Airports Average Capacity Gain 12-17 Arrivals/Hour		
Detroit	Little Rock	Orlando
Grand Rapids	Memphis	Phoenix
	Nashville	Pittsburgh

Figure 3-2. Parallel Instrument Approaches Using the Final Monitor Aid (FMA)



3.3 Independent Parallel Approaches to Triple and Quadruple Runways Using Current Radar Systems

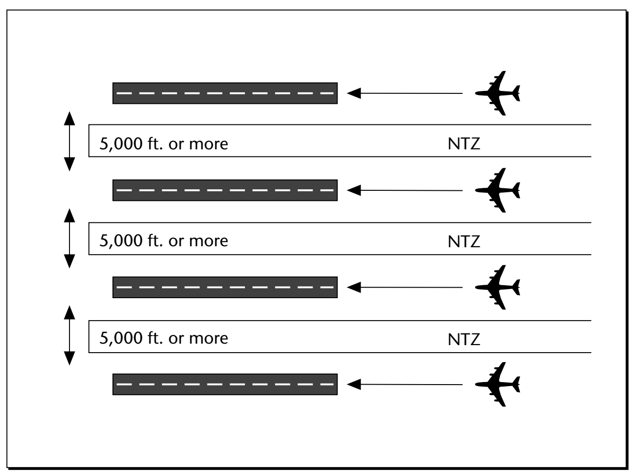
Several airports, including Dallas-Fort Worth, Orlando, and Pittsburgh, are planning to build parallel runways that will give them the capability to conduct triple and quadruple independent parallel approaches. This could result in as much as a 50 percent increase in arrival capacity for triple parallel arrivals and a 100 percent increase for quadruple arrivals.

Procedures allowing triple independent approaches to parallel runways separated by 5,000 feet, at airports with field elevations of less than 1,000 feet with current radar systems, were published in May 1993. Simulations for development of procedures for quadruple approaches are tentatively planned for the future. Figure 3-3 illustrates triple and quadruple parallel approaches. Additional simulations will be conducted to determine the minimum runway spacing (less than 5,000 feet) for independent parallel approaches to triple and quadruple runways. Table 3-2 lists airports that have or plan to have parallel runways separated by 2,500 to 4,300 feet and indicates the average capacity gains expected from these improved approaches.

Table 3-2. Candidate Airports for Independent Parallel Approaches to Triple and Quadruple Runways

Candidates Among Top 100 Airports Average Capacity Gain 30 Arrivals/Hour
Dallas-Ft. Worth Denver Orlando Pittsburgh

Figure 3-3. Triple and Quadruple Parallel Approaches



3.4 Simultaneous Operations on Wet Intersecting Runways

Currently, simultaneous operations on intersecting runways require that the runways be dry. Over the past several years, demonstrations have been conducted at various airports using simultaneous operations on wet runways. Due to the success of these demonstrations, the FAA has initiated action to establish a national standard for allowing simultaneous operations on intersecting wet runways.

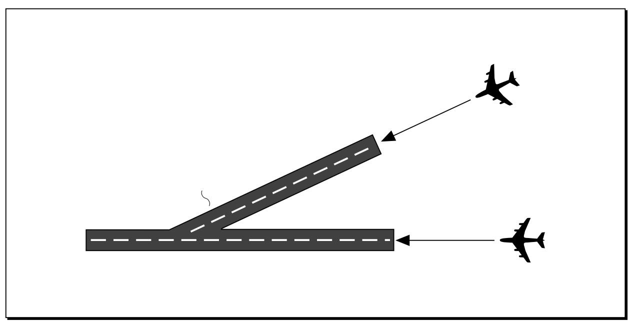
Of the top 100 airports, 60 currently conduct simultaneous operations on intersecting runways. Demonstrations have been ongoing at Boston Logan, Greater Pittsburgh, and Chicago O'Hare. Demonstrations are planned at New York's Kennedy, Philadelphia, and Miami International Airports. At O'Hare, increases of up to 25 percent have been experienced during wet runway operations.

An FAA team is in the process of formalizing procedures for these types of operations so that a national standard for simultaneous operations on wet intersecting runways can be established. The target for implementation is 1996. Figure 3-4 illustrates simultaneous operations on wet intersecting runways. Table 3-3 lists airports that are candidates to conduct simultaneous operations on wet intersecting runways.

Table 3-3. Candidate Airports for Simultaneous Operations on Wet Intersecting Runways

Candidates Among Top 100 Airports Top 13 Candidate Airports		
Boston	Miami	Philadelphia
Charlotte/Douglas	Minneapolis-St. Paul	Pittsburgh
Chicago O'Hare	New York (JFK)	San Francisco
Detroit	New York (LGA)	Washington National
	St. Louis	

Figure 3-4. Simultaneous Operations on Wet Intersecting Runways



3.5 Improved Operations on Parallel Runways Separated by Less Than 2,500 Feet

Current procedures consider parallel runways separated by less than 2,500 feet as a single runway during IFR operations. Simultaneous use of these runways for arrivals and departures is prohibited. This imposes a significant capacity penalty at numerous high-density airports. A recent analysis determined that airports such as Boston Logan International and Philadelphia International could achieve delay savings of over 80,000 hours per year if they were able to run dependent parallel arrivals. Table 3-4 lists airports that are candidates to conduct improved operations on parallel runways separated by less than 2,500 feet.

The FAA's Wake Vortex Program has been redefined to focus directly on the safety requirements for arrival and departure operations to parallel runways separated by less than 2,500 feet. One of the ojectives of the program will be to determine if there is sufficient evidence supporting a reduction in the 2,500 foot requirement.

Table 3-4. Candidate Airports for Improved Operations on Parallel Runways Separated by Less Than 2,500 Feet

Candidates Among Top 100 Airports		
Atlanta	Long Beach	Palm Beach
Boise	Los Angeles	Philadelphia
Boston	Memphis	Phoenix
Chicago Midway	Midland	Pittsburgh
Cincinnati	Milwaukee	Providence
Cleveland	Nashville	Raleigh-Durham
Dallas-Ft. Worth	New Orleans	Reno
Des Moines	New York (JFK)	San Antonio
Detroit	Newark	San Francisco
El Paso	Norfolk	San Jose
Houston Hobby	Oakland	Santa Ana
Houston Intercont'l	Oklahoma City	Seattle-Tacoma
Islip	Omaha	St. Louis
Knoxville	Ontario	Tucson
Las Vegas	Orlando	Washington Dulles

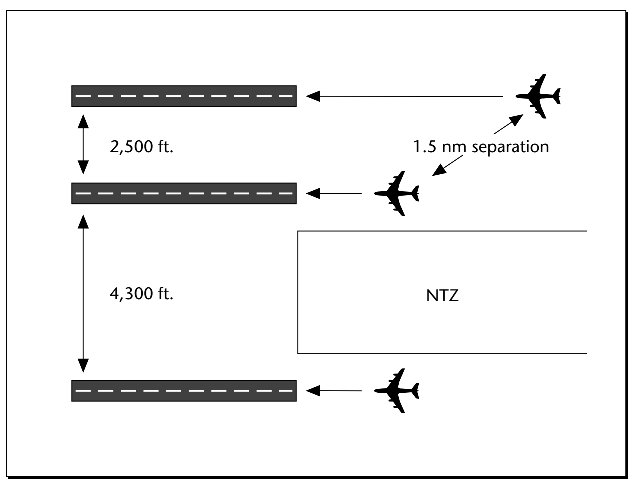
3.6 Dependent Approaches to Three Parallel Runways

Procedures have been proposed that would allow approaches to three parallel runways when two may be operated independently of each other because of sufficient spacing and the third is dependent upon one of the others because of insufficient spacing. Currently, procedures allow simultaneous approaches to runways with centerlines spaced at least 3,400 feet apart, provided a Precision Runway Monitor (PRM) is available. However, those airports with spacing from 2,500 to 3,400 between one set of runways and 3,400 to 4,300 feet or more between the other set are limited to dual runway operations. Real-time simulations will be scheduled in the future to test proposed procedures that will allow triple operations using dependent operations between one set of parallels and independent operations between the other set. Figure 3-5 illustrates independent and dependent parallel approaches, and Table 3-5 lists airports that are candidates for these improved approaches.

Table 3-5. Candidate Airports for Dependent Approaches to Three Parallel Runways

Candidates Among Top 100 Airports Average Capacity Gain 15 Arrivals/Hour		
Charlotte/Douglas	Detroit	Pittsburgh
Chicago O'Hare	Houston Intercont'l	Salt Lake City
Denver	Orlando	Washington Dulles

Figure 3-5. Independent and Dependent Parallel Approaches



3.7 Simultaneous (Independent) Converging Instrument Approaches

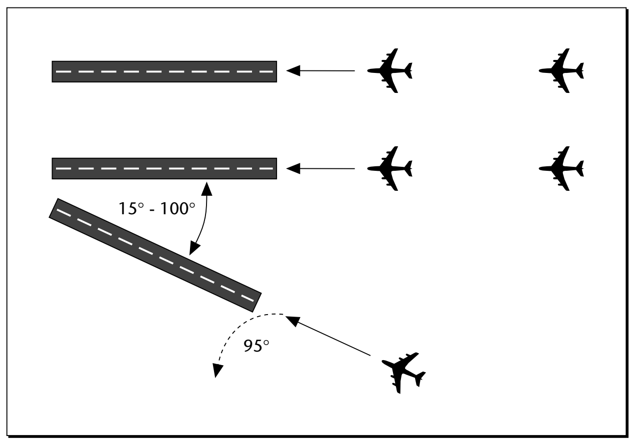
Under VFR conditions, it is common for air traffic control (ATC) to use converging runways for independent streams of arriving aircraft. In 1986, the FAA established a procedure for conducting independent instrument approaches to converging runways under Instrument Meteorological Conditions (IMC). This procedure uses non-overlapping Terminal Instrument Procedures (TERPS) obstacle clearance criteria as a means of providing required separation for aircraft in the event of simultaneous missed approaches to the converging runways. This procedure assumes that each aircraft, in executing a turning missed approach, can keep its course within the limits of its respective "TERPS+3". When the above conditions are satisfied, no dependency between the two aircraft on the converging approaches is required. Hence, the independent nature of the procedure was established.

The requirement to maintain 3 nm distance between MAPS ensuring no TERPS overlap, however, creates restrictions to landing minimums and adds to decision heights. To establish TERPS+3 approach geometry, the MAPS must be moved back away from the runway thresholds. As a result, many runway configurations require decision heights significantly greater than 700 feet in order to satisfy TERPS+3 criteria. This restricts the application of the procedure to operations close to the boundary between visual flight rules (VFR) and instrument flight rules (IFR) and limits the number of airports that

Table 3-6. Candidate Airports for Independent Converging Approaches

Candidates Among Top 100 Airports Average Capacity Gain 30 Arrivals/Hour		
Baltimore	Houston Intercont'l	Oakland
Boston	Indianapolis	Omaha
Charlotte	Jacksonville	Philadelphia
Chicago Midway	Kansas City	Pittsburgh
Chicago O'Hare	Louisville	Portland
Cincinnati	Miami	Providence
Dallas-Ft. Worth	Milwaukee	Rochester
Dayton	Minneapolis	San Antonio
Denver	Nashville	San Francisco
Detroit	New York (JFK)	St. Louis
Ft. Lauderdale	New York (LGA)	Washington Dulles
Honolulu	New Orleans	Windsor Locks
Houston Hobby	Newark	

Figure 3-6. Triple Approaches: Dual Parallels and One Converging



could benefit from the procedure. Finally, the procedure cannot be used if the converging runways intersect unless controllers can establish visual separation, and the ceiling and visibility are at or above 700 feet and 2 statute miles (SM). This requirement increases controller work load.

In an effort to refine the converging approach procedures and obtain greater operational efficiency for the users, the Converging Approach Standards Technical Work Group (CASTWG) was formed. This is a multi-discipline work group chartered to analyze and develop concepts which would result in lower approach minimums and greater capacity for converging operations. A systematic engineering data collection and proof-of-concept testing effort is underway yielding immediate operational benefits. This effort employs testing in state-of-the-art flight simulators using qualified airline crews to validate findings and required TERPS surfaces. The CASTWG work focuses on the use of advanced technology avionics, Flight Management Systems (FMS), and new procedures to achieve optimal operational minimums. Following the data collection phase and real-time simulation, flight testing and demonstrations will validate the new standards. The preliminary analysis of this program's accomplishments to date, indicates significant benefits will be realized at several high density airports in the very near term, with added benefits to many other airports in the immediate future.

Figure 3-6 illustrates the triple approaches, with dual parallels and one converging. Table 3-6 lists airports that are candidates to conduct these independent converging approaches and indicates the average capacity gains expected from these improved approaches.

3.8 Dependent Converging Instrument Approaches

Typically, independent converging IFR approaches using the TERPS+3 criteria are feasible only when ceilings are above 700 feet, depending upon runway geometry. As an alternative precision approach procedure, dependent IFR operations can be conducted to much lower minimums, usually down to Category I, thus expanding the period of time during which the runways can be used. However, to conduct these dependent operations efficiently, controllers need an automated method for ensuring that the aircraft on the different approaches remain safely separated. Without such a method, the separation of aircraft would be so large that little capacity would be gained.

A program was conducted at St. Louis (STL) to evaluate dependent operations using a controller automation aid called the Converging Runway Display Aid (CRDA) (also called ghosting or mirror imaging) to maintain aircraft stagger on approach. The CRDA displays an aircraft at its actual location and simultaneously displays its image at another location on the controllers scope to assist the controller in assessing the relative positions of aircraft that are on different approach paths. Results at St. Louis have shown an increase in arrival rates from 36 arrivals per hour to 48 arrivals per hour. National standards for this procedure were published in November 1992. The CRDA function is implemented in version A3.05 of the ARTS IIIA system.

The CRDA may also have other applications (see Section 5.2.1.1). For example, it could be used at airports with intersecting runways that have insufficient length to allow hold-short operations. Insufficient runway length between the threshold and the intersection with another runway can be ignored if arrivals are staggered such that the first one is clear of the intersection before the second one crosses its respective threshold.

3.9 Traffic Alert and Collision Avoidance System (TCAS)/Cockpit Display of Traffic Information (CDTI) for Separation Assistance

The display of traffic information on the flight deck from sources such as Automatic Dependent Surveillance and tcas offers the potential for flight crews to assist air traffic controllers in monitoring and reducing the spacing requirements during many phases of flight. Figure 3-7 illustrates one example of this use of a tcas/cdti. Use of this information should result in capacity and efficiency improvements beyond those which are available using only radar and voice communications.

A TCAS/CDTI feasibility study that was published in 1991 recommended exploration of this technology to enhance ATC procedures. Under the auspices of the FAA/industry Separation Assistance Working Group (SAWG), concepts for the use of tcas procedural applications were subjected to interactive simulations. Reliability, safety and human factors data was gathered and explored through the use of full motion simulators. Procedures were validated in a simulated environment.

Initial emphasis has been on the use of a TCAS/CDTI to support oceanic in-trail climbs (ITC). In this application, the flight crew of an airplane that is following another along an oceanic route utilized the surveillance and display capabilities of the tcas to determine a minimum safe distance behind the airplane ahead. Once validated, the flight crew provides that information to air traffic control and requests clearance to climb to a higher altitude. This effectively reduces the non-radar in-trail distance necessary to approve the climb from a nominal 100 nm to a minimum of 15 nm. In April 1994, the first two validation flights took place over the Pacific Ocean. By late summer of 1994, two major U.S. airlines began operational trials of the itc procedure in the Anchorage and Oakland Flight Information Regions (FIRs), with more expected to join the trials by early 1996.

Beginning in early 1996, an in-trail descent (ITD), an extension of the ITC, will be introduced into Pacific oceanic operations. The success of the ITC has accelerated software enhancements to TCAS and serves as a cornerstone in the development of the "free flight" concept. Further applications that take advantage of TCAS/CDTI capabilities can be expected to offer additional efficiency and capacity improvements in the foreseeable future.

Figure 3-7. TCAS/CDTI for Separation Assistance